Importance of Proactively Managing Aging Fire Protection Systems in Industrial Facilities

By Kyle Christiansen, PE, Registered Fire Protection Engineer

Over the past several years, our fire protection experts have seen more local authorities having jurisdiction (AHJ) cite multiple industrial facilities for deficiencies during fire protection system inspections. In one instance, the AHJ threatened to shut down site operations if a plan was not put in place immediately to rectify the violation. Unforeseen business interruptions like this can have significant adverse consequences to operations and erode the relationship between the AHJ and facility.

One of the primary challenges for industrial facilities is that fire protection systems are typically not part of normal operations and may only operate during the required testing periods. Fire protection systems are made of materials susceptible to environmental degradation over long exposure periods, and owners must maintain these systems in accordance with National Fire Protection Association and International Building Code requirements. In addition, fire protection systems cannot be abandoned unless formally decommissioned; therefore, owners can expect to perform these inspections over the life of the system. It is important for facility owners to understand the results of these required tests, which may indicate degradation of the fire protection system and foreshadow system failures or an inability to pass future inspections. This article will focus on common issues found in underground fire protection piping systems and possible solutions for proactively identifying these issues.

Consequences of Degrading Fire Protection Infrastructure

Environmental factors play a significant role in how a fire protection system ages. Underground mains constructed of metal, especially cast iron, are particularly susceptible to the soil's moisture content, pH, resistivity, and oxygen content. Fire protection system piping exteriors may corrode from prolonged contact with acidic or moist soils, which can compromise the integrity of the piping wall to withstand the static pressure. This, unfortunately, might result in unexpected catastrophic system failures during a fire event or pressure testing and may also result in failure to meet pressure testing requirements.

The characteristics of the fire protection system's water supply can have major impacts on the internal pipe integrity and reduce hydraulic performance over time. Fouling and blockage can affect fire protection system piping by reducing the inner diameter of the pipe, leading to increased pressure losses under flow conditions. Additionally, contaminants such as salt and microorganisms in the water supply can corrode susceptible piping, fittings, and interior pipe protective coatings. This may be discovered over time and reflected in reduced hydraulic performance during routine testing of fire pumps and fire hydrant flow tests. NFPA performed a study comparing the C-factor (a correlation for the roughness of the pipe) for unlined cast iron pipe as a function of time. The C-factor of the cast iron piping degrades significantly over the 50-year duration of the study, which may affect the ability of the system to perform as designed or compromise firefighter response.

Both interior and exterior fire protection system degradations can cause costly interruptions to business operations when a fire protection system is unexpectedly offline. The fire marshal could also determine deficiencies warrant a temporary shutdown until a plan is in place to address them. In addition, industry experience has shown unplanned replacements are more costly compared to planned replacements or modifications that can be performed during system outages and spread over multiple year's budgets and capital expenses.

Solutions for Staying Ahead of Fire Protection Aging Infrastructure

Many industrial facilities discover issues with fire protection systems during routine inspection, testing and maintenance (ITM) performed according to the NFPA 25 standard as required by the International Fire Code or NFPA 1, which places responsibility for properly maintaining the system on the owner. Other facilities discover issues when evaluating their current fire protection infrastructure in anticipation of expanding operations.

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In general, to avoid surprises, facilities need to proactively monitor the performance of their fire protection systems to maintain business continuity, operations, and capabilities to facilitate future expansion. What options are available? HDR's Fire and Life Safety (FLS) team includes licensed fire protection engineers, NICET IV certified individuals in water-based systems layout and fire alarm systems, former building and fire code officials, certified inspectors and plans examiners, risk consultants, and loss prevention specialists. These fire protection specialists have identified the following solutions based on our experience.

- Evaluate the condition of the underground piping by performing an NFPA 291 compliant fire hydrant flow test. These test results would then be used to create a hydraulic model to predict the theoretical flow. Comparing the actual flow results with the theoretical values from the hydraulic model will show if certain areas of the piping network are affected or if issues are systemic.
    - If issues are limited to a small section of the system, facilities can consider replacing the degraded section or inserting a lining into the pipe to reduce friction losses.
    - If hydraulic issues are systemic, it may require replacement of the entire piping network.
- Ultrasonic thickness testing allows for wall thickness measurements and exterior visual inspections for corrosion without taking piping out of service. This unobtrusive testing can predict the pipe wall's ability to withstand its design pressure as the wall thickness changes. Consider performing this testing every 3 to 5 years for pipe over 15 years old to track the wall thickness over time. The compiled data can be used to make predictions about when to replace the pipe prior to failure.
- Perform studies of the environment to which the pipe is exposed. This includes sampling studies to characterize the pH, dissolved oxygen, conductivity of the soil, and any microorganisms that may be contributing to microbiologically influenced corrosion. Data obtained from routine testing can be used to substantiate predictions of when to replace a system.
- Utilize consultants specializing in fire protection systems to support fire marshal interactions and justify compensatory measures or alternate design solutions to provide equivalent levels of fire protection.

In summary, industrial facilities should be aware of the condition of their fire protection systems by performing recurring reviews of the code-required testing and inspection results, proactively inspecting the condition of the pipe's interior and exterior, and measuring the thickness of the pipe walls. Such proactive behavior can help identify fire protection system susceptibilities, minimize pipe infrastructure failures, and eliminate unanticipated interruptions in business operations. Staying ahead of aging infrastructure increases the flexibility for economical decision making and reduces operational downtime when a proactive, rather than reactive, approach is applied.

References

1. NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.*
2. NFPA 1, *Fire Code*.
3. *NFPA Fire Protection Handbook*, 20th Edition.
4. NFPA 291, *Recommended Practice for Fire Flow Testing and Marking of Hydrants*.